NEWTON'S LAW OF MOTION

LEVEL-ROOT

FIRST LAW

If $\vec{F}=0$, then $\vec{a}=0;\vec{v}=$ constant

1. A particle is moving with a constant speed along a straight line path. A force is not required to
   (a) increase its speed (b) decrease the momentum
   (c) change the direction (d) keep its moving with uniform velocity
2. A man getting down a running bus falls forward because
   (a) due to inertia of rest, road is left behind and man reaches forward
   (b) due to inertia of motion upper part of body continues to be in motion in forward direction while feet come to rest as soon as they touch the road
   (c) He leans forward as a matter of habit
   (d) Of the combined effect of all the three factors stated in (a), (b) and (c)
3. When a bus suddenly takes a turn, the passengers are thrown outwards because of
   (a) inertia of direction (b) acceleration of motion
   (c) speed of motion (d) both (b) and (c)

SECOND LAW

$\vec{p}=m\vec{v};$

$\vec{F}=\frac{d\vec{p}}{dt}=m\vec{a}$

1. If a bullet of mass 5 gm moving with velocity 100 m/sec, penetrates the wooden block upto 6 cm. Then the average force imposed by the bullet on the block is
   (a) 8300 N (b) 417 N (c) 830 N (d) zero
2. A body of mass 0.4 kg starting at origin at t = 0 with a speed of 10 m/s in the positive x-axis direction is subjected to a constant force F = 8 N towards negative x-axis. Calculate the position of the particle after 25 seconds
   (a) –6000 m (b) –8000 m (c) +4000 m (d) +7000m
3. The velocity of a body of mass 20 kg decreases from 20 m/s to 5 m/s in a distance of 100 m. Force on the body is
   (a) –27.5 N (b) –47.5 (c) –37.5 N (d) –67.5 N
4. A ball of mass 0.2 kg is thrown vertically upwards by applying a force by hand. If the hand moves 0.2 m while applying the force and the ball goes upto 2 m height further, find the magnitude of the force. Consider g = 10 m/s^2

(a) 16 N (b) 20 N (c) 22 N (d) 4 N

5. A body of mass 0.05 kg is observed to fall with an acceleration of 9.5 ms^{-2}. The opposing force of air on the body is (g = 9.8 ms^{-2})

(a) 0.015 N (b) 0.15 N (c) 0.030 N (d) zero

6. A 10 kg stone is suspended with a rope of breaking strength 30 kg wt. The minimum time in which the stone can be raised through a height 10 m starting from rest is (taking g = 10 N/kg)

(a) 0.5 seconds (b) 1.0 seconds (c) $\sqrt{\frac{2}{3}}$ seconds (d) 2.0 seconds

7. A particles moves in the x-y plane under the influence of a force such that its linear momentum is $\vec{p}(t) = A[\hat{i}\cos(kt) - \hat{j}\sin(kt)]$ where A and k are constants. The angle between the force and momentum is

(a) 0^o (b) 30^o (c) 45^o (d) 90^o

8. A balloon with mass m is descending down with an acceleration a (where a < g). How much mass should be removed from it so that it starts moving up with an acceleration a.

(a) $\frac{ma}{g+a}$ (b) $\frac{ma}{g-a}$ (c) $\frac{2ma}{g+a}$ (d) $\frac{2ma}{g-a}$

9. A person of mass 60 kg is inside a lift of mass 940 kg and presses the button one control panel. The lift starts moving upwards with an acceleration 1.0 m/s^2. If g = 10 ms^{-2}, the tension in the supporting cable is

(a) 1200 N (b) 8600 N (c) 9680 N (d) 11000 N

10. Same force acts on two bodies of different masses 3 kg and 5 kg initially at rest. The ratio of times required to acquire same final velocity is

(a) 5 : 3 (b) 25 : 9 (c) 9 : 25 (d) 3 : 5

11. A solid disc of mass M is just held in air horizontally by throwing 40 stones per sec upwards to strike the disc each a velocity 6 ms^{-1}. If the mass of each stone is 0.05 kg what is the mass of disc (g = 10 ms^{-2})

(a) 1.2 kg (b) 0.5 kg (c) 20 kg (d) 3 kg

12. A sphere is accelerated upwards by a cord whose braking strength is four times its weight. The maximum acceleration with which the sphere can move up without breaking the cord is

(a) g (b) 3g (c) 2g (d) 4g

13. An army vehicle of mass 1000 kg is moving with a velocity of 10 m/s and is acted upon by a forward force of 1000 N due to the engine and a retarding force of 500 N due to friction . What will be its velocity after 10 s

(a) 5 m/s (b) 10 m/s (c) 15 m/s (d) 20 m/s

14. A block of mass 5 kg is moving horizontally at a speed of 1.5 m/s. A perpendicular force of 5N acts on it for 4 sec. What will be the distance of the block from the point where the force started acting

(a) 10 m (b) 8 m (c) 6 m (d) 2m

15. The average force necessary to stop a bullet of mass 20 g moving with a speed of 250 m/s, as its penetrates into the wood for distance of 12 cm is

(a) 2.2×10^3 N (b) 3.2×10^3 N (c) 4.2×10^3 N (d) 5.2×10^3 N

16. When a bullet is fired at a target, its velocity decreases by half after penetrating 30 cm into it. The additional thickness it will penetrate before coming to rest is

(a) 30 cm (b) 40 cm (c) 10 cm (d) 50 cm

17. A body of mass 5 kg starts from the origin with an initial velocity $\vec{u} = 30\hat{i} + 40\hat{j}\ ms^{-1}$. If a constant force $\vec{F} = -(\hat{i} + 5\hat{j})N$ acts on the body, the time in which the y-component of the velocity becomes zero is

(a) 5 sec (b) 20 sec (c) 40 sec (d) 80 sec

18. A monkey of mass 20 kg is holding a vertical rope. The rope will not break when a mass of 25 kg is suspended from it but will break if the mass exceeds 25 kg. What is the maximum acceleration with which the monkey can climb up along the rope ($g = 10\ m/s^2$)

(a) $10\ m/s^2$ (b) $25\ m/s^2$ (c) $2.5\ m/s^2$ (d) $5\ m/s^2$

19. The linear momentum p of a body moving in one dimension varies with time according to the equation $p = a + bt^2$ where a and b are positive constants. The net force acting on the body is

(a) A constant (b) Proportional to t^2

(c) Inversely proportional to t (d) Proportional to t

20. A player caught a cricket ball of mass 150 gm moving at the rate of 20 m/sec. If the catching process be completed in 0.1 sec the force of the blow exerted by the ball on the hands of player is

(a) 0.3 N (b) 30 N (c) 300 N (d) 3000 N

21. n small balls each of mass m impinge elastically each second on a surface with velocity u. The force experienced by the surface will be

(a) mnu (b) 2 mnu (c) 4 mnu (d) 1/2 mnu

22. A force vector applied on a mass is represented as $\vec{F} = 6\hat{i} - 8\hat{j} + 10\vec{k}$ and accelerate with $1\ m/s^2$. What will be the mass of the body

(a) $10\sqrt{2}\,kg$ (b) $2\sqrt{10}\,kg$ (c) 10 kg (d) 20 kg

THIRD LAW

1. A man is standing at the centre of frictionless pond of ice. How can he get himself to the shore

(a) By throwing his shirt in vertically upward direction

(b) By throwing his shirt in horizontal direction

(c) He will wait for the ice to melt in pond

(d) Unable to get at the shore

2. A man is standing at a spring platform. Reading the spring balance is 60 kg wt. If man jumps outside the platform, then reading of spring balance

(a) First increases then decreases to zero

(b) Decreases

(c) Increases

(d) Remains same

3. When a horse pulls a wagon, the force that causes the horse to move forward is the force

(a) The ground exerts on it (b) It exerts on the ground

(c) The wagon exerts on it (d) It exerts on the wagon

BLOCK CONNECTED WITH STRING

1. Two bodies of mass 3 kg and 4 kg are suspended at the ends of massless string passing over a frictionless pulley. The acceleration of the system is ($g = 9.8\ m/s^2$)

(a) $4.9\ m/s^2$ (b) $2.45\ m/s^2$ (c) $1.4\ m/s^2$ (d) $9.5\ m/s^2$

2. A block of mass m_1 rests on a horizontal table. A string tied to the block is passed on a frictionless pulley fixed at the end of the table and to the other end of string is hung another block of mass m_2. The acceleration of the system is

(a) $\frac{m_2 g}{(m_1 + m_2)}$ (b) $\frac{m_1 g}{(m_1 + m_2)}$ (c) g (d) $\frac{m_2 g}{m_1}$

3. A light string passes over a frictionless pulley. To one of its ends of mass of 6 kg is attached. To its other end of mass of 10 kg is attached. The tension in the thread will be

(a) 24.5 N (b) 2.45 N (c) 79 N (d) 73.5 N

4. A light string passing over a smooth light pulley connects two blocks of masses m_1 and m_2 (vertically). If the acceleration of the system is $g/8$ then the ratio of the masses is

(a) 8 : 1 (b) 9 : 7 (c) 4 : 3 (d) 5 : 3

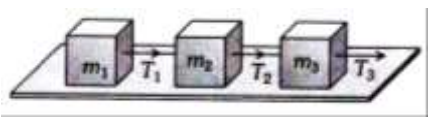
5. A block of mass M placed on a frictionless horizontal table is pulled by another block of mass m having vertically by a massless string passing over a frictionless pulley. The tension in the string is

(a) $\frac{m}{M+m}g$ (b) $\frac{M}{M+m}g$ (c) $\frac{M+m}{Mm}g$ (d) $\frac{Mm}{M+m}g$

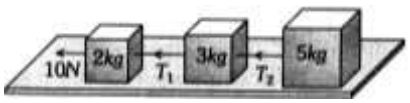
6. Three blocks of masses m_1, m_2 and m_3 are connected by massless strings as shown on a frictionless table. They are pulled with a force $T_3 = 40$ N. If $m_1 = 10$ kg, $m_2 = 6$ kg and $m_3 = 4$kg, the tension T_2 will be

(a) 20 N (b) 40 N

(c) 10 N (d) 32 N



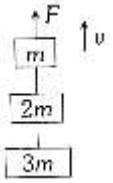
7. Three blocks of masses 2 kg, 3 kg and 5 kg are connected to each other with light string and are then placed on a frictionless surface as shown in the figure. The system is pulled by a force F = 10 N, then tension T_1 =



(a) 1 N (b) 5 N

(c) 8 N (d) 10 N

8. Three blocks with masses m, 2m and 3m are connected by string as shown in figure. After an upward force F is applied on block m, the masses move upward at constant speed v. What is the net force on the block of mass 2m (g is the acceleration due to gravity)



(a) 6 mg (b) zero

(c) 2 mg (d) 3 mg

BLOCKS IN CONTACT

1. Three blocks A, B and C of masses 4 kg, 2 kg and 1 kg respectively, are in contact on a frictionless surface. If a force of 14 N is applied on the 4 kg block then the contact force between A and B is

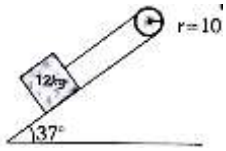
(a) 6 N (b) 8 N (c) 18 N (d) 2 N

2. Two blocks of masses 7 kg and 5 kg are placed in contact with each other on a smooth surface. If a force of 6 N is applied on the heavier mass, the force on the lighter mass is

(a) 3.5 N (b) 2.5 N (c) 7 N (d) 5 N

BLOCKS ON INCLINE PLANE

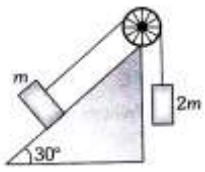
1. A body shown in figure is accelerating downward with acceleration 2 m/s^2. The tension in the string is



(a) 48 N (b) 50 N

(c) 30 N (d) 42 N

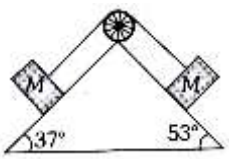
2. Two blocks of masses m and 2m are connected by a light string passing over a frictionless pulley. As shown in the figure, the mass m is placed on smooth inclined plane of inclination 30° and 2 m hangs vertically. If the system is released, the block move with an acceleration equal to



(a) g/4 (b) g/3

(c) g/2 (d) g

3. The acceleration of system of two bodies over the wedges as shown in figure is



(a) 1 ms^{-2} (b) 2 ms^{-2}

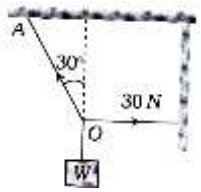
(c) 0.5 ms^{-2} (d) 10 ms^{-2}

4. A block of mass 15 kg is held by a string on an inclined plane (angle 30°). The tension T in the string is (g = 10 m/s^2)

(a) 55 N (b) 60 N (c) 75 N (d) 90 N

EQUILIBRIUM OF FORCES

1. Three concurrent coplanar forces 1 N, 2N and 3 N acting along different directions on a body
   (a) Can keep the body in equilibrium if 2 N and 3 N act at right angle
   (b) Can keep the body in equilibrium if 1 N and 2 N act at right angle
   (c) Cannot keep the body in equilibrium
   (d) Can keep the body in equilibrium if 1 N and 3 N act at an acute angle
2. Three forces F_1, F_2 and F_3 together keep a body in equilibrium. If F_1 = 3N along the positive x-axis, F_2 = 4 N along the positive y-axis, then the third force F_3 is
   (a) 5 N making an angle $\theta = \tan^{-1}(3/4)$ with negative y-axis
   (b) 5 N making an angle $\theta = \tan^{-1}(4/3)$ with negative y-axis
   (c) 7 N making an angle $\theta = \tan^{-1}(3/4)$ with negative y-axis
   (d) 7 N making an angle $\theta = \tan^{-1}(4/3)$ with negative y-axis
3. As shown in figure the tension in the horizontal cord is 30 N. The weight W and tension in the string OA in Newton are



   (a) $30\sqrt{3}$, 30 (b) $30\sqrt{3}$, 60
   (c) $60\sqrt{3}$, 30 (d) none of these

APPARENT WEIGHT

Apparent weight = normal force by surface = N

1. A person is standing in an elevator. In which situation he finds his weight less than actual weight
   (a) the elevator moves upwards with constant acceleration
   (b) the elevator moves downward with constant acceleration
   (c) the elevator moves upward with uniform velocity
   (d) the elevator moves downwards with uniform velocity
2. A person is measuring his weight by standing on a weighing machine inside a lift. When the lift is at rest, the machine shows his weight to be 55 kg. In between the floor when the lift is moving up with a constant speed of 10 km/hr, he again measures his weight which is
   (a) 55 kg (b) 65 kg (c) 50 kg (d) 45 kg
3. A boy having a mass equal to 40 kilograms is standing in an elevator. The force felt by the feet of the boy will be greatest when the elevator (g = 9.8 metres/sec^2)
   (a) stands still
   (b) moves towards at a constant velocity of 4 metre/sec
   (c) accelerates downward with an acceleration equal to 4 metre/sec^2
   (d) accelerates upward with an acceleration equal to 4 metre/sec^2
4. The ratio of the weight of a man in a stationary lift and when it is moving downward with uniform acceleration 'a' is 3 : 2. The value of 'a' is (g-Acceleration due to gravity of the earth)

(a) 3/2 g (b) g/3 (c) 2/3 g (d) g

5. A body of mass 1.0 kg falling with an acceleration of 10 m/sec^2. Its apparent weight will be (g = 10 m/sec^2)

(a) 1.0 kg wt (b) 2.0 kg wt (c) 0.5 kg wt (d) zero

STRING WITH MASS

1. A block of mass m is pulled along a horizontal frictionless surface by a rope of mass m. If a force P is applied at the free end of the rope, the force exerted by the rope on the block will be

(a) P (b) $\frac{Pm}{M+m}$ (c) $\frac{PM}{M+m}$ (d) $\frac{PM}{M-m}$

2. A rope of length L is pulled by a constant force F. What is the tension in the rope at a distance x from the end where the force is applied

(a) FL/x (b) $\frac{F(L-x)}{L}$ (c) $\frac{FL}{L-x}$ (d) $\frac{Fx}{L-x}$

3. A rope of length 5 m is kept on frictionless surface and a force of 5 N is applied to one of its end. Find the tension in the rope at 1 m from this end

(a) 1 N (b) 3 N (c) 4 N (d) 5 N

4. A block of mass m is resting on a smooth horizontal surface. One end of a uniform rope of mass (m/3) is fixed to the block, which is pulled in the horizontal direction by applying a force F at the other end. The tension in the middle of the rope is

(a) 8/7 F (b) 1/7 F (c) 1/8 F (d) 7/8 F

NON-INERTIAL FRAME

Pseudo force = mass of body × acceleration of frame

1. A spring balance is attached to the ceiling of a lift. A man hangs his bag on the spring and the spring reads 49 N, when the lift is stationary. If the lift moves downward with an acceleration of 5 m/s^2, the reading of the spring balance will be

(a) 49 N (b) 24 N (c) 74 N (d) 15 N

2. If a person with a spring balance and a body hanging from it goes up and down with acceleration in an aeroplane, then the reading of the weight of the body as indicated by the spring balance will

(a) Go on increasing (b) Go on decreasing

(c) First increase, then decrease (d) Remain the same

3. A plumb line is suspended from a ceiling of a car moving with horizontal acceleration of a. What will be the angle of inclination with vertical

(a) $\tan^{-1}$ (a/g) (b) $\tan^{-1}$ (g/a) (c) $\cos^{-1}$ (a/g) (d) $\cos^{-1}$ (g/a)

CONSERVATION OF LINEAR MOMENTUM AND IMPULSE

$J = F.\Delta t$

If $J = 0$, then $P_i = P_f$

$\Rightarrow m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

1. A shell of mass 10 kg is moving with a velocity of 10 ms^{-1} when it blasts and forms two parts of mass 9 kg and 1 kg respectively. If the 1st mass is stationary, the velocity of the 2nd is

   (a) 1 m/s (b) 10 m/s (c) 100 m/s (d) 1000 m/s

2. A shell at rest at the origin explodes into three fragments of masses 1 kg, 2 kg and m kg. The 1 kg and 2 kg pieces fly off with the speed of 5 ms^{-1} along x-axis and 6 ms^{-1} along y-axis respectively. If the m kg piece flies off with a speed of 6.5 ms^{-1}, the total mass of the shell must be

   (a) 4 kg (b) 5 kg (c) 3.5 kg (d) 4.5 kg

3. A batsman hits back a ball of mass 0.15 kg straight in the direction of the bowler without changing its initial speed of 10 ms^{-1}. If the ball moves linearly, then the impulse imparted on it (in Ns) is

   (a) 3.0 (b) 2.0 (c) 1.5 (d) 1.9

4. A 100 g iron ball having velocity 10 m/s collides with a wall at an angle 30^o and rebounds with the same angle. If the period of contact between the ball and wall is 0.1 second, then the force experienced by the wall is

   (a) 10 N (b) 100 N (c) 1.0 N (d) 0.1 N

5. A ball of mass 150 g starts moving with an acceleration of 20 m/s^2. When hit by a force, which acts on it for 0.1 sec the impulsive force is

   (a) 0.5 N-s (b) 0.1 N-s (c) 0.3 N-s (d) 1.2 N-s

6. A man fires a bullet of mass 200 g at a speed of 5 m/s. The gun is of one kg mass. By what velocity the gun rebounds backwards

   (a) 0.1 m/s (b) 10 m/s (c) 1 m/s (d) 0.01 m/s

7. A body of mass 1000 kg is moving horizontally with a velocity 50 m/s. A mass of 250 kg is added. Find the final velocity

   (a) 40 m/s (b) 20 m/s (c) $30\sqrt{2}\,m/s$ (d) 50 m/s

8. A bullet of mass 10 g moving with 300 m/s hits a block of ice of mass5 kg and drops dead. The velocity of ice is

   (a) 50 cm/s (b) 60 cm/s (c) 40 cm/s (d) 30 cm/s

9. A machine gun fires a bullet of mass 40 g with a velocity 1200 ms^{-1}. The man holding it can exert a maximum force of 144 N on the gun. How many bullets can he fire per second at the most

   (a) One (b) Four (c) Two (d) Three

ANSWER

FIRST LAW

1. (d) 2. (b) 3. (a)

SECOND LAW

1. (b) 2. (a) 3. (c) 4. (b) 5. (a) 6. (b)
7. (d) 8. (c) 9. (d) 10. (d) 11. (a) 12. (b)
13. (c) 14. (a) 15. (d) 16. (c) 17. (c) 18. (c)
19. (d) 20. (b) 21. (b) 22. (a)

THIRD LAW

1. (b) 2. (a) 3. (a)

BLOCK CONNECTED WITH STRING

1. (c) 2. (a) 3. (d) 4. (b) 5. (d) 6. (d) 7. (c)
8. (b)

BLOCKS IN CONTACT

1. (a) 2. (b)

BLOCKS ON INCLINE PLANE

1. (a) 2. (c) 3. (a) 4. (c)

EQUILIBRIUM OF FORCES

1. (c) 2. (a) 3. (b)

APPARENT WEIGHT

1. (b) 2. (a) 3. (d) 4. (b) 5. (d)

STRING WITH MASS

1. (b) 2. (b) 3. (c) 4. (d)

NON-INERTIAL FRAME

1. (b) 2. (c) 3. (a)

CONSERVATION OF LINEAR MOMENTUM AND IMPULSE

1. (c) 2. (b) 3. (a) 4. (a) 5. (c) 6. (c)
7. (a) 8. (b) 9. (d)

VARIABLE MASS PROBLEM

1. (d) 2. (c) 3. (c) 4. (d) 5. (d) 6. (b)